

Magnetic, chemically peculiar (CP2) stars in the SuperWASP survey

K. Bernhard^{1,2,*}, S. Hümmerich^{1,2}, and E. Paunzen³

¹ Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV), Berlin, Germany

² American Association of Variable Star Observers (AAVSO), Cambridge, USA

³ Department of Theoretical Physics and Astrophysics, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

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The magnetic chemically peculiar (CP2) stars of the upper main sequence are well-suited for investigating the impact of magnetic fields on the surface layers of stars, which leads to abundance inhomogeneities (spots) resulting in photometric variability. The light changes are explained in terms of the oblique rotator model; the derived photometric periods thus correlate with the rotational periods of the stars. CP2 stars exhibiting this kind of variability are classified as α^2 Canum Venaticorum (ACV) variables. We have analysed around 3 850 000 individual photometric WASP measurements of magnetic chemically peculiar (CP2) stars and candidates selected from the Catalogue of Ap, HgMn, and Am stars, with the ultimate goal of detecting new ACV variables. In total, we found 80 variables, from which 74 are reported here for the first time. The data allowed us to establish variability for 23 stars which had been reported as probably constant in the literature before. Light curve parameters were obtained for all stars by a least-squares fit with the fundamental sine wave and its first harmonic. Because of the scarcity of Strömberg $uvby\beta$ measurements and the lack of parallax measurements with an accuracy better than 20%, we are not able to give reliable astrophysical parameters for the investigated objects.

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1 Introduction

The group of chemically peculiar (CP) stars on the upper main sequence displays peculiar lines and line strengths, in addition to other peculiar features such as a strong global stellar magnetic field (Babcock 1947). One can usually distinguish between Am (CP1), Si as well as SrCrEu (CP2), HgMn (CP3), and He-weak/strong (CP4) stars (Preston 1974). The subgroup of CP2 objects, which comprises B to F-type stars, is characterized by variable line strengths and radial velocity changes as well as photometric variability of in general the same periodicity. CP2 stars typically have overabundances of up to several dex for Si, Sr, Cr, Eu, and other rare earth elements as compared to the Sun (Saffe et al. 2005); the overabundances of the respective elements are strongly correlated with effective temperature.

Photometric variability of the CP2 star α^2 Canum Venaticorum (ACV) was first reported by Guthnik & Prager (1914). The light curves of CP stars can be fitted well by a sine wave and its first harmonic with varying amplitudes depending on the photometric filter systems (North 1984). For some CP stars, a double-wave structure of the photometric light curves depending on the observed wavelength region is detected (Maitzen 1980). However, similar magnetic field modulus variations are rather rare exceptions (Mathys et al. 1997).

The variability of CP2 stars is explained in terms of the oblique rotator model (Stibbs 1950), according to which the period of the observed variations is simply the rotational period. Accurate knowledge of the rotational period and its evolution in time is a fundamental step in understanding the complex behaviour of CP2 stars, especially as far as it concerns the phase relation between the magnetic, spectral, and light variations (Mikulášek et al. 2010).

Recently, Balona et al. (2015) presented an analysis of the light curves of 29 CP1 stars from the Kepler satellite mission. They found 12 δ Scuti variables, one γ Doradus star and 10 stars, whose variability is in accordance with rotational modulation caused by spots. However, the amplitudes of the detected variability is between 4 and 200 ppm which, normally, cannot be achieved via ground based observations. This demonstrates that, apparently, even this subgroup of CP stars shows rotationally induced variability. However, Aurière et al. (2010) found that none of the 15 investigated A-type stars of peculiarity types other than CP2/4 hosts a surface-averaged longitudinal magnetic field of more than 3 Gauss. They concluded that there exists a magnetic dichotomy corresponding to a gap of more than one order of magnitude in field strength.

Furthermore, photometric variability among cool-type (F, G, and K) stars due to the presence of starspots is a common phenomenon. Nielsen et al. (2013) published rotational periods of 12 000 main-sequence stars based on observations by the Kepler satellite mission. As expected, they found that hot stars (earlier than A-type) rotate faster than

* Corresponding author: e-mail: klaus.bernhard@liwest.at, ernham@rz-online.de

Table 1 Essential data and light curve fit parameters for the 80 stars identified as photometrically variable chemically peculiar stars.

Star	Period [d]	Epoch (HJD) [d]	A_1 [mag]	A_2 [mag]	ϕ_1 [rad]	ϕ_2 [rad]	Spectral type	$(B - V)$ [mag]	$(J - K_s)$ [mag]
HD 653	1.0845(1)	2453978.60(3)	0.0034	0.0039	0.56	0.43	A0 Cr Eu	+0.111	+0.021
HD 7341	1.8815(9)	2454325.68(4)	0.0147	0.0015	0.14	0.46	A3 Si	+0.003	-0.035
HD 8892	1.782(3)	2454323.63(3)	0.0179	0.0078	0.80	0.80	A0 Si	+0.073	-0.034
BD+51 469	1.638(2)	2454332.27(3)	0.0038	0.0020	0.63	0.25	A Si	+0.043	-0.016
BD+36 467	6.221(5)	2453971.5(1)	0.0097	0.0015	0.04	0.96	A Sr Eu	+0.300	+0.118
HD 15357	2.591(4)	2454348.35(5)	0.0085	0.0051	0.82	0.53	B9 Si	+0.151	+0.018
HD 237040	1.3078(8)	2454350.36(3)	0.0530	0.0146	0.12	0.55	B9 Si	+0.243	+0.070
HD 18410A	5.09(2)	2454347.0(1)	0.0242	0.0039	0.82	0.64	A2 Si Cr Eu	+0.239	+0.050
BD+41 600	5.056(1)	2453197.0(1)	0.0141	0.0026	0.68	0.75	A2 Si	+0.076	-0.050
BD+49 1011	14.2(1)	2453192.2(3)	0.0067	0.0013	0.27	0.01	A0 Cr Eu	+0.165	+0.080
HD 279110	0.94622(2)	2453217.11(2)	0.0063	0.0107	0.81	0.15	B9 Si Sr Cr	+0.144	+0.033
HD 24786	3.0554(8)	2453963.73(9)	0.0036	0.0001	0.45	0.20	A0 Cr Eu Sr	+0.120	+0.017
HD 276179	1.2799(3)	2454359.12(2)	0.0034	0.0076	0.67	0.05	B8 Si	+0.288	+0.112
HD 30335	5.100(4)	2454362.9(1)	0.0041	0.0055	0.17	0.50	A2 Sr Eu Cr	+0.162	+0.027
HD 284639	9.136(1)	2453223.1(2)	0.0059	0.0039	0.00	0.47	A0 Si Cr	+0.478	+0.141
HD 31463	1.445(2)	2454394.55(3)	0.0196	0.0105	0.80	0.04	B8 Si	+0.000	-0.009
HD 34439	1.602(2)	2454397.56(3)	0.0258	0.0032	0.38	0.47	A Si	+0.062	-0.050
HD 280980	12.50(1)	2453221.9(2)	0.0127	0.0017	0.97	0.35	B9 Si	+0.240	+0.092
HD 281056	34.3(2)	2453269(1)	0.0091	0.0019	0.87	0.40	B9 Si Cr Sr	+0.116	+0.076
HD 243395	1.7605(7)	2453219.86(3)	0.0075	0.0005	0.72	0.02	A0 Si Sr	+0.297	+0.086
HD 243954	3.065(3)	2454145.41(5)	0.0035	0.0010	0.92	0.76	A1 Si	+0.157	+0.026
HD 244531	1.2802(3)	2454017.73(3)	0.0030	0.0063	0.90	0.03	B9 Si	-0.139	+0.151
BD+38 1211	1.3444(3)	2454070.72(3)	0.0057	0.0033	0.47	0.40	A0 Si	-0.054	-0.016
BD+26 859	1.2378(1)	2454011.62(2)	0.0090	0.0015	0.35	0.96	B8 Si Sr	+0.028	+0.188
TYC 2412-87-1	1.1070(5)	2454143.37(2)	0.0061	0.0042	0.23	0.36	B8 Si Sr	+0.107	+0.046
HD 245153	2.854(3)	2454008.73(5)	0.0016	0.0044	0.65	0.98	A0 Si Sr	+0.286	+0.160
HD 245990	1.549(4)	2454069.63(3)	0.0110	0.0030	0.99	0.09	A1 Si	+0.462	+0.180
TYC 2408-1757-1	3.5116(2)	2454031.71(7)	0.0105	0.0275	0.04	0.18	B9 Si	+0.038	+0.034
HD 246993	1.1013(1)	2454122.50(3)	0.0079	0.0011	0.84	0.33	B9 Si	+0.057	+0.062
BD+35 1238	6.680(2)	2454100.6(1)	0.0270	0.0010	0.41	0.35	B9 Si Sr	+0.186	+0.073
HD 247664	3.034(5)	2454139.45(6)	0.0105	0.0031	0.56	0.37	B9 Si Sr	+0.148	+0.038
HD 247931	14.52(1)	2453269.8(3)	0.0230	0.0040	0.81	0.61	B7 Si	+0.167	-0.010
HD 248072	1.12172(8)	2454145.46(2)	0.0070	0.0040	0.57	0.99	B9 Si Cr	+0.182	+0.026
HD 38943	3.435(1)	2454099.5(1)	0.0093	0.0130	0.23	0.94	A Si	+0.123	+0.061
HD 248619	1.7823(5)	2454070.52(4)	0.0130	0.0061	0.69	0.41	B9 Si Sr	+0.127	+0.038
HD 248815	4.173(6)	2454148.45(9)	0.0126	0.0038	0.00	0.51	B9 Si	+0.300	+0.108
HD 248769	2.588(3)	2454031.61(6)	0.0144	0.0012	0.98	0.14	B8 Si Sr	+0.087	+0.030
HD 250515	10.58(7)	2454141.5(2)	0.0190	0.0043	0.30	0.92	A0 Si	+0.057	+0.022
HD 41282	9.33(5)	2454139.5(2)	0.0078	0.0012	0.34	0.80	B9 Si	+0.074	-0.009
HD 41251	4.0395(5)	2454098.5(1)	0.0250	0.0092	0.51	0.75	B9 Si	-0.036	-0.004
HD 41844	2.0328(3)	2454454.50(4)	0.0069	0.0099	0.07	0.80	A0 Si	-0.064	-0.096
BD+25 1117	10.98(1)	2454086.0(3)	0.0067	0.0004	0.66	0.42	B8 Si	+0.000	+0.071
HD 251879	8.434(5)	2454139.5(2)	0.0092	0.0019	0.95	0.54	B9 Sr	+0.370	-0.006
HD 252106	1.8119(5)	2454135.63(4)	0.0108	0.0020	0.61	0.06	A0 Si	-0.094	+0.007
HD 252104	1.7674(2)	2454085.70(3)	0.0058	0.0055	1.00	0.27	B9 Si Sr	+0.062	+0.069
HD 256008	1.5577(2)	2453240.74(3)	0.0126	0.0053	0.58	0.33	A2 Sr	+0.248	+0.038
CD-35 2960	0.94116(8)	2454111.33(2)	0.0068	0.0072	0.75	0.94	A0 Si	-0.033	-0.063
HD 47284	6.854(3)	2454417.6(1)	0.0028	0.0096	0.92	0.68	A5 Si Eu Cr	+0.432	+0.058
HD 49797	1.2263(1)	2454154.37(3)	0.0076	0.0006	0.22	0.82	B9 Si	-0.111	-0.039
HD 268471	1.1295(8)	2453271.70(2)	0.0040	0.0004	0.79	0.84	A2 Cr Eu	+0.134	+0.017
HD 80992	3.381(8)	2454476.60(7)	0.0114	0.0039	0.91	0.31	A2 Sr Cr	+0.219	+0.108
HD 83181	2.5241(3)	2454570.26(5)	0.0094	0.0066	0.12	0.43	A0 Cr Eu Si	+0.036	-0.007
HD 93700	3.164(8)	2454142.6(1)	0.0028	0.0004	0.16	0.65	A0 Sr Eu	+0.239	+0.014
HD 96537	4.305(1)	2454208.37(9)	0.0062	0.0064	0.50	0.28	A3 Sr Cr Eu	+0.288	+0.041
HD 107107	9.50(2)	2454537.3(2)	0.0089	0.0026	0.30	0.33	A2 Cr Eu Sr	+0.179	+0.048
HD 107180	10.073(8)	2454580.5(2)	0.0030	0.0026	0.66	0.35	A2 Eu Cr Sr	+0.413	+0.131
HD 109030	0.8537(4)	2454123.76(2)	0.0101	0.0023	0.67	0.67	A0 Sr	+0.075	-0.018
HD 119277	2.774(1)	2454594.40(6)	0.0090	0.0035	0.40	0.64	B9 Si	-0.085	-0.071
HD 128649	2.6014(3)	2454184.53(5)	0.0091	0.0127	0.57	0.49	A0 Cr Si Eu	+0.114	+0.070
HD 129102	1.710(3)	2454572.50(3)	0.0030	0.0070	0.35	0.70	B9 Si	+0.028	-0.072
HD 131750	3.318(3)	2454230.65(8)	0.0065	0.0124	0.74	0.43	A2 Sr Cr Eu	+0.267	+0.076
HD 131753	1.7583(3)	2453892.34(3)	0.0091	0.0028	0.75	0.64	B9 Si	-0.038	-0.054
HD 135708	2.9644(3)	2453862.35(5)	0.0052	0.0053	0.67	0.64	A0 Si	-0.023	+0.034
HD 142459	1.7272(2)	2453860.39(2)	0.0075	0.0035	0.77	0.21	A0 Si	+0.188	+0.105
HD 143541	0.8887(1)	2454200.07(1)	0.0070	0.0009	0.90	0.76	A0 Si	+0.453	+0.216
HD 148117	2.0579(1)	2454269.11(4)	0.0169	0.0024	0.22	0.66	A7 Si Eu Cr	+0.160	+0.194
BD+32 2827	13.236(6)	2453128.5(2)	0.0019	0.0033	0.88	0.60	Sr Eu Cr	+0.263	-0.009
HD 169887	4.46(1)	2453130.3(1)	0.0135	0.0015	0.55	0.38	A0 Si	+0.017	+0.020
HD 234924	8.483(5)	2454234.1(1)	0.0232	0.0040	0.71	0.69	A2 Sr	-0.045	-0.012
HD 195464	2.704(3)	2454272.25(6)	0.0102	0.0076	0.73	0.62	A0 Si	-0.096	-0.116
HD 340768	3.6036(8)	2453129.57(8)	0.0230	0.0030	0.57	0.61	B9 Si	-0.082	-0.087
HD 199187	1.7485(2)	2453862.05(5)	0.0043	0.0068	0.74	0.15	A0 Si	-0.024	-0.047
BD+31 4539A	1.6619(1)	2453993.55(2)	0.0320	0.0084	0.48	0.26	A0 Si	-0.033	-0.008
TYC 3614-2039-1	2.266(3)	2454279.71(6)	0.0135	0.0083	0.80	0.73	A0 Si	+0.036	-0.011
HD 212714	2.9197(3)	2453128.89(6)	0.0041	0.0118	0.02	0.46	A0 Si	+0.040	-0.002
BD+44 4130	2.851(2)	2454290.71(5)	0.0279	0.0015	0.17	0.67	A0 Si	-0.009	-0.002
HD 212899	1.583(2)	2454279.58(3)	0.0064	0.0019	0.99	0.50	A0 Si	+0.002	+0.008
HD 214985	1.3851(1)	2453862.68(3)	0.0028	0.0004	0.60	0.67	A0 Si	-0.024	-0.045
BD+47 4044	13.8(1)	2454297.7(2)	0.0223	0.0098	0.07	0.49	B8 Si	+0.133	+0.020
BD+46 3957	7.58(2)	2454293.2(1)	0.0100	0.0065	0.51	0.86	A Si Sr	+0.167	-0.016

their cooler counterparts. However, it is important to connect all these observations to create a global picture of the rotational behaviour of stars.

In this paper, we present the results of the WASP light curve analysis of bona fide CP2 stars and candidates. Among the 579 investigated objects, we detected 80 ACVs, from which 74 are reported for the first time.

Observations, target selection, and reductions are described in Sect. 2; data analysis is characterized in Sect. 3; results are presented and discussed in Sect. 4. We conclude in Sect. 5.

2 Observations, target selection and reductions

The main aim of the WASP project is the detection of transiting extrasolar planets. Two robotic telescopes are employed, which are situated at the Observatorio del Roque de los Muchachos (La Palma) and the South African Astronomical Observatory (SAAO). Each telescope consists of an array of eight f/1.8 200mm Canon lenses and 2048 x 2048 Andor CCD detectors, covering a field of $7.8^\circ \times 7.8^\circ$ of sky with an angular size of $13.7''$ / pixel (Pollacco et al. 2006). Initially, observations were taken unfiltered; from 2006 onwards, a broadband filter with a passband from ~ 4000 to $\sim 7000\text{\AA}$ was employed. Each field was observed about every 9 to 12 minutes (Butters et al. 2010). The first data release (DR1) of the WASP archive, which encompasses light curve data from 2004 to 2008, boasts ~ 18 million light curves covering a large fraction of the sky and provides good photometry for objects in the magnitude range $8 \leq V \leq 14$ mag.

A list of targets was established by selecting bona-fide CP2 stars from the Catalogue of Ap, HgMn and Am stars (Renson & Manfroid 2009, RM09 hereafter). The objects in this catalogue are not explicitly subdivided in the CP groups established by Preston (1974). We used the listed spectral types therein to distinguish between CP1 stars and the other subgroups (mainly denoted as ‘Si’, ‘Sr’, ‘Sr Eu Si’, ‘He-weak’, ‘Hg Mn’, and so on). All objects in this list boasting at least 1 000 data points in WASP DR1 were investigated. In total, 579 objects were found to meet these criteria.

The corresponding data were downloaded from the WASP archive at the computing and storage facilities of the CERIT Scientific Cloud¹ (Paunzen et al. 2014). To avoid the most significant saturation effects, all objects brighter than $V < 8$ mag were eliminated. A lower magnitude cut-off was not deemed necessary as there are only 40 objects in the RM09 catalogue with $V > 14$ mag.

3 Data Analysis

As a first step, all light curves were inspected visually and obvious outliers and data points associated to exceedingly

large error bars were removed. The data were then searched for periodic signals in the frequency domain of $0 < f \text{ (c/d)} < 50$ using PERIOD04 (Lenz & Breger 2004). Objects exhibiting periodic signals well above the noise level (corresponding to a semi-amplitude of at least ~ 0.005 mag, as determined with PERIOD04) were subjected to a more detailed analysis. In this second step, the data were binned in order to increase the accuracy of the measurements. Depending on the length of the dataset, the number and cadence of observations and the quality of the data, different bin-sizes from 0.005 – 0.05 d were chosen. The data were then carefully cleaned from remaining systematic trends, which were mostly of instrumental origin or due to blending issues. In addition to that, the data of some stars in the magnitude range $8 < V < 9$ mag were also found to suffer from significant systematic trends likely due to saturation effects (cf. Smalley et al. 2014). In some cases, the severity of artifacts present in the data necessitated the removal of entire epochs or the complete dataset of one of the WASP cameras.

WASP observations are often made up of distinctive parts separated by observational gaps of varying length in the data. Where this applied, shifts in mean magnitude between the corresponding parts of the data were sometimes observed. The light curves were consequently detrended by shifting all parts of the data to the mean magnitude of the combined dataset. In some cases, systematic trends introduced spurious periods in the data and might have effectively masked any low-amplitude variability present. Stars exhibiting a weak signal that could not be attributed to systematic trends but did not produce a convincing phase plot either, were generally rejected in order to keep the sample free of possibly spurious detections that might contaminate the sample of derived rotational periods.

The data were searched for periodic signals using the Phase Dispersion Method (PDM) of Stellingwerf (1978) and the Analysis of Variance (ANOVA) statistic developed by Schwarzenberg-Czerny (1996), as implemented in the PERANSO software package (Paunzen & Vanmunster 2015). Periods were searched in the range of $0.1 < P \text{ (d)} < 50$. The resulting power spectra were examined for significant features, and the data were folded with the resulting best-fitting periods and visually inspected. Objects exhibiting convincing phase plots were considered for inclusion in the final sample. The General Catalogue of Variable Stars (GCVS, Samus et al. 2007 – 2014), the AAVSO International Variable Star Index, VSX (Watson 2006), the VizieR (Ochsenbein et al. 2000), and SIMBAD (Wenger et al. 2000) databases were consulted to check for an entry in variability catalogues. Objects that have already been announced as ACV variables in the literature were dropped from our sample, the only exception being V499 Per, for which only a tentative period has been published in the literature.

It has been shown in the literature that, in most cases, the light curves of CP2 stars can be well represented by a sine wave and its first harmonic (e.g. Heck et al. 1987; Mathys & Manfroid 1985; North 1984). A least-squares fit

¹ <http://wasp.cerit-sc.cz/>

to the observations was done using the program package PERIOD04. Each light curve was fitted using a Fourier series consisting of the fundamental sine wave and its first harmonic, from which the corresponding amplitudes and their phases were derived. The light curve parameters (A_1 , A_2 , ϕ_1 , and ϕ_2) are listed in Table 1.

The object was finally classified according to spectral type, colour information, period and shape of the light curve. The observed variability pattern of all stars in the present sample is in accordance with rotational modulation caused by spots. For some few cases, the discrimination between the light curves of double-waved ACVs and the variability induced by orbital motion (ellipsoidal variables/eclipsing variables) is not straightforward. As the incidence of ellipsoidal or eclipsing variables among CP2 stars is very low (Bernhard et al. 2015; Gerbaldi et al. 1985; Hubrig et al. 2014; North & Debernardi 2004), we are inclined to interpret the observed variability as being due to rotational modulation. The initial period search with PERIOD04 in the frequency range up to 50 c/d also resulted in the discovery of six new δ Scuti variables. These will be dealt with in an upcoming paper.

Table 1 lists the results and some additional observational data. It is organised as follows:

- Column 1: Star name, HD number, or other conventional identification
- Column 2: Period (d)
- Column 3: Epoch (HJD), time of maximum
- Column 4: Amplitude of the fundamental variation (A_1)
- Column 5: Amplitude of the first harmonic variation (A_2)
- Column 6: Phase of the fundamental variation (ϕ_1)
- Column 7: Phase of the first harmonic variation (ϕ_2)
- Column 8: Spectral classification, as listed in RM09
- Column 9: ($B-V$) index, taken from Kharchenko (2001)
- Column 10: ($J-K_s$) index, as derived from the 2MASS catalogue (Skrutskie et al. 2006).

In agreement with the findings of other investigators, we confirm that WASP data are very well suited to investigate variable stars with low photometric amplitudes (cf. Smalley et al. 2014).

4 Results

The following stars have already been studied in the past and discussed in more detail.

HD 8892: Koen & Eyer (2002) published a period of 1.77945 d based on Hipparcos photometry. Within the errors, this is in line with our result. Rimoldini et al. (2012) classified it as slowly pulsating B-type star using automatic classification based on Bayesian networks (probability of 0.58) and the prediction by random forests (probability of 0.33). The spectral classification of Ap Si (Cowley & Cowley 1965) is consistent with its colours. We are therefore confident that this is a true CP2 and ACV object.

HD 18410A: The period of 5.08053 d listed by Koen & Eyer (2002) is in agreement with the one derived by us. Rimoldini et al. (2012) list a variable type of either ‘BE + GCAS’ or ACV depending on the used classification method.

HD 41251: V448 Aur, there are two different variability types found in the literature. The VSX catalogue lists it as slowly pulsating B-type star whereas Dubath et al. (2011) list an ACV type. The given periods are comparable to ours.

HD 131750: Strohmeier et al. (1966) reported variability for this star (NSV 6859). They do not list a period but a photographic amplitude of 0.35 mag, which - originating in an early type object - is rather large if due to rotation and/or pulsation. In the same paper, three additional A-type stars of comparable amplitudes are presented (HD 148891, HD 188297, and HD 204370), which are all eclipsing binary systems. However, our data show no eclipses, which is also supported by an analysis of Hipparcos data. In addition, the search for roAp characteristics gave a null result (Freyhammer et al. 2008).

HD 250515: This star is listed in the ASAS Catalogue of Variable Stars (ASAS, Pojmański et al. 2005) as a ‘MISC’ type object with a period of 0.47683 d. Wraight et al. (2012) found no variability whereas Richards et al. (2012) list a period of 0.9116 d and an ACV type (probability of 0.4). The period that produces the best fit to the WASP data (10.58 d) is much longer than the ones that have been reported before. In order to investigate this issue, we have combined WASP and ASAS data, with the latter dataset consisting of only 47 datapoints. The 10.58 d period produces the best fit to the combined data.

HD 279110: This star (V499 Per) is located in the Perseus OB1 association. The period analysis by North (1987) was not conclusive (possible period of 0.48 or 0.96 d) due to the small number of available observations. From the WASP data, which have an excellent spatial coverage, we can definitely conclude that 0.94622 d is the correct period.

HD 284639, HD 243395, HD 243954, HD 244531, BD+26 859, HD 245153, HD 245990, TYC 2408-1757-1, HD 246993, HD 247664, HD 247931, HD 248072, HD 248619, HD 248769, HD 248815, HD 41282, BD+25 1117, HD 251879, HD 252106, HD 252104, HD 256008, HD 268471, and HD 148117: These 23 stars were reported as constant or probably constant by Wraight et al. (2012), who analysed the light curves of 337 probable magnetic chemically peculiar stars obtained with the STEREO spacecraft. 82 stars were detected as variable, of which 48 were reported for the first time. The authors stated that the stars, which are classified as constant, might be intrinsically variable if their period is, for example, longer than 10 d or their light curve is affected by substantial blending or systematic effects. From the sample, only five stars have periods close or above 10 d (Table 1): HD 284639 (9.136 d), HD 247931 (14.52 d), HD 41282 (9.33 d), BD+25 1117 (10.98 d), HD 251879 (8.434 d).

In accordance with the findings of previous investigators (e.g. Heck et al. 1987; Mathys & Manfroid 1985; North 1984), our light curve analysis confirms that the light curves

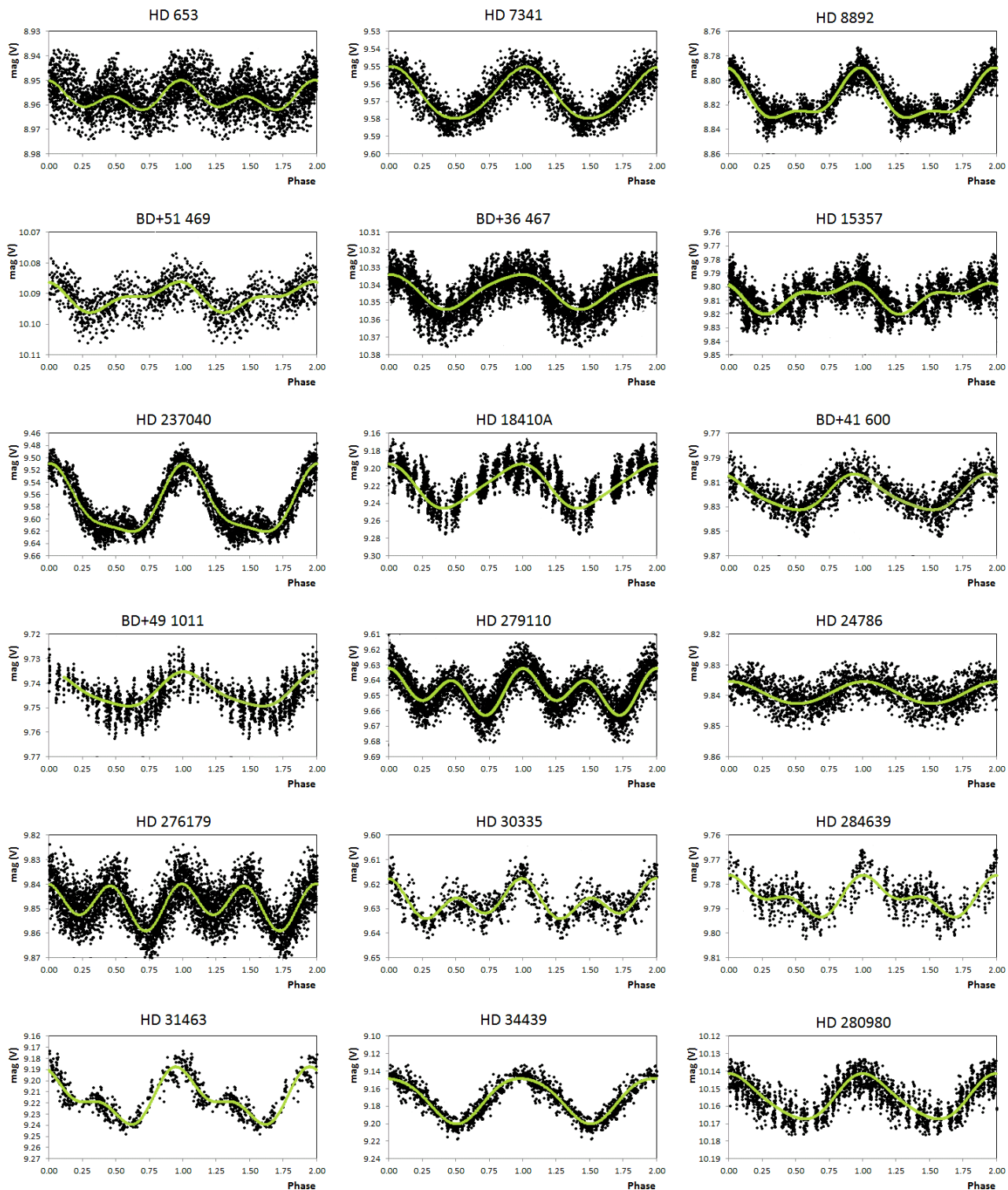


Fig. 1 The light curves of all objects, folded with the period listed in Table 1. The fit curves corresponding to the light curve parameters given in Table 1 are indicated by the solid lines.

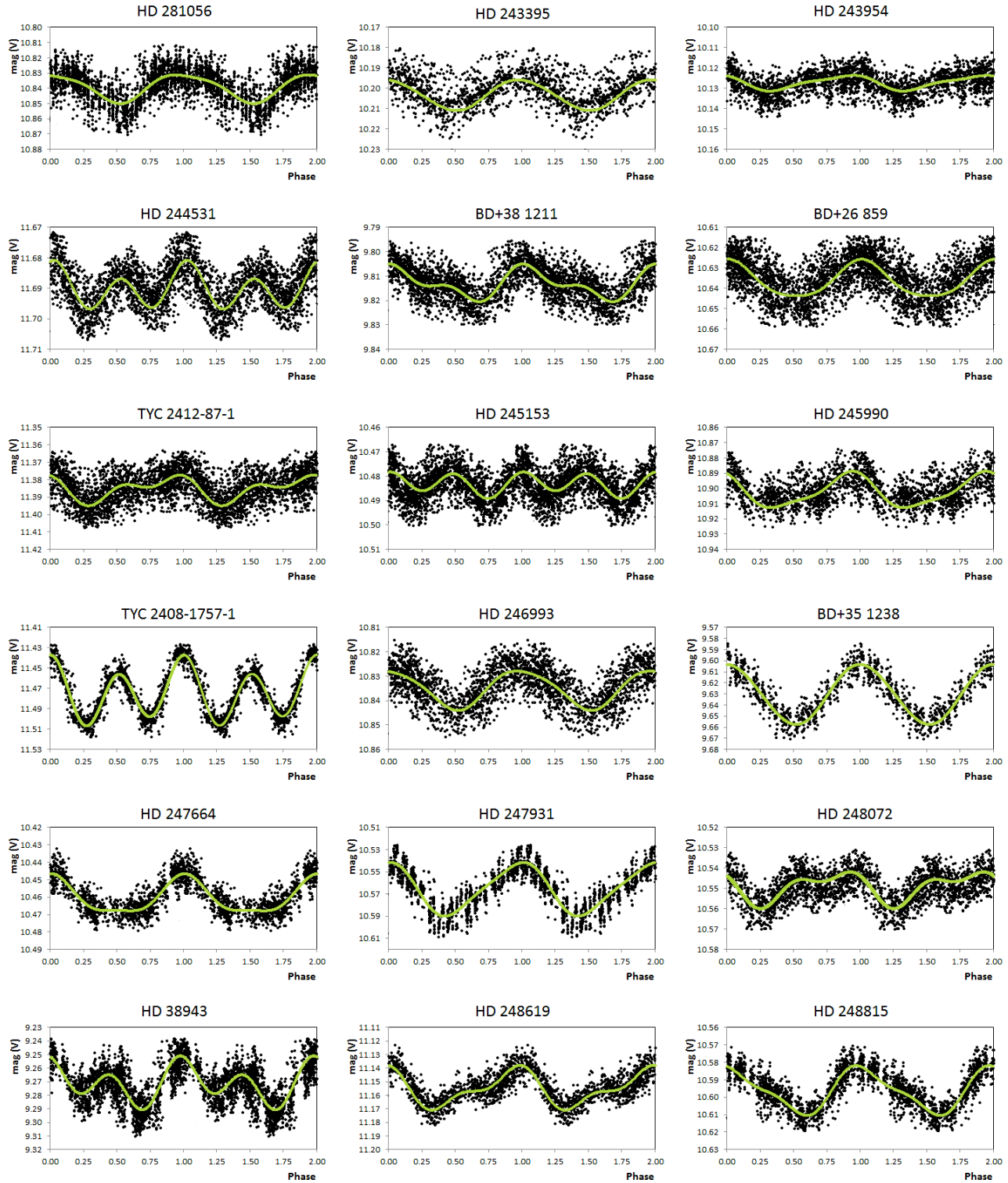


Fig. 1 continued.

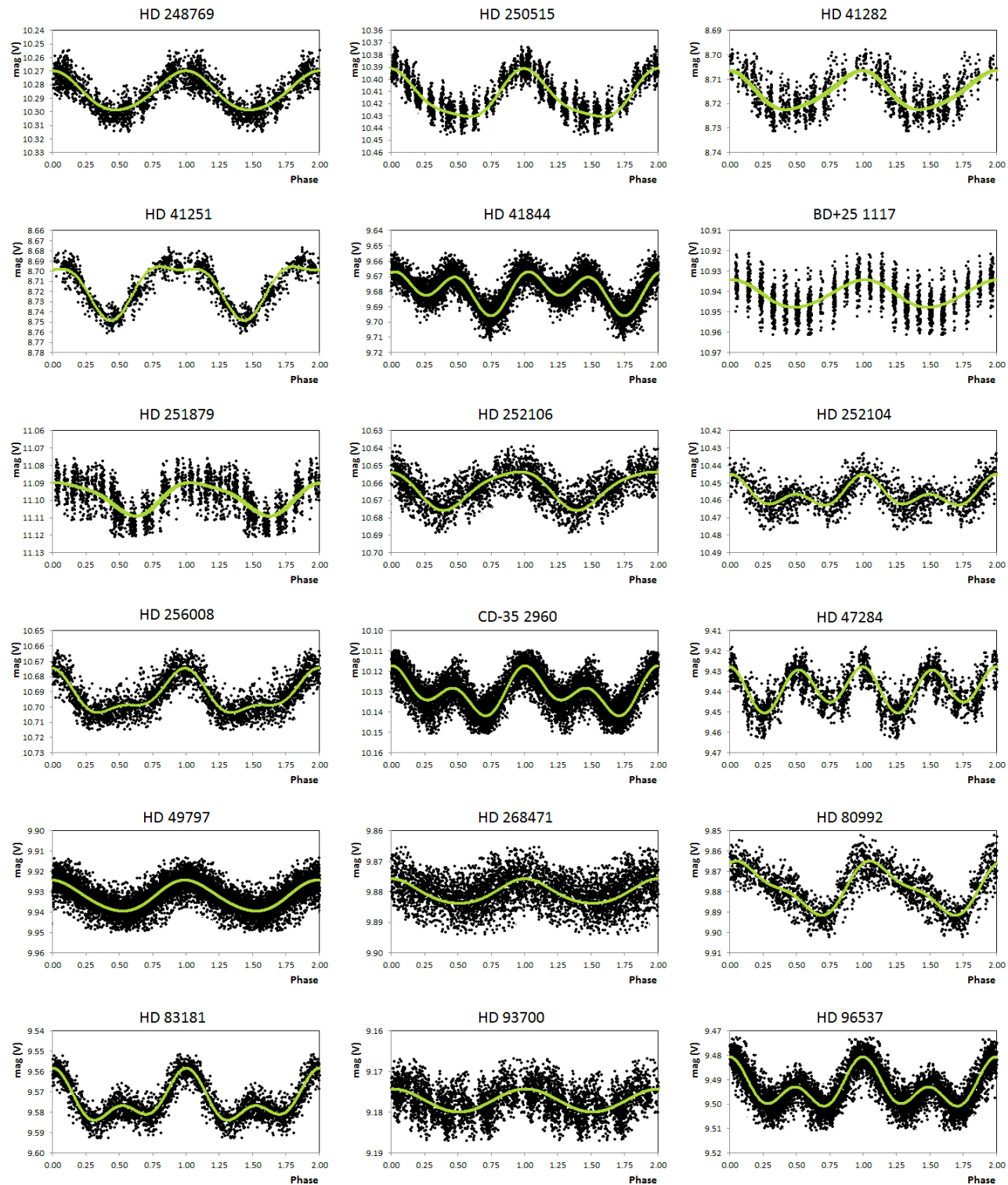


Fig. 1 continued.

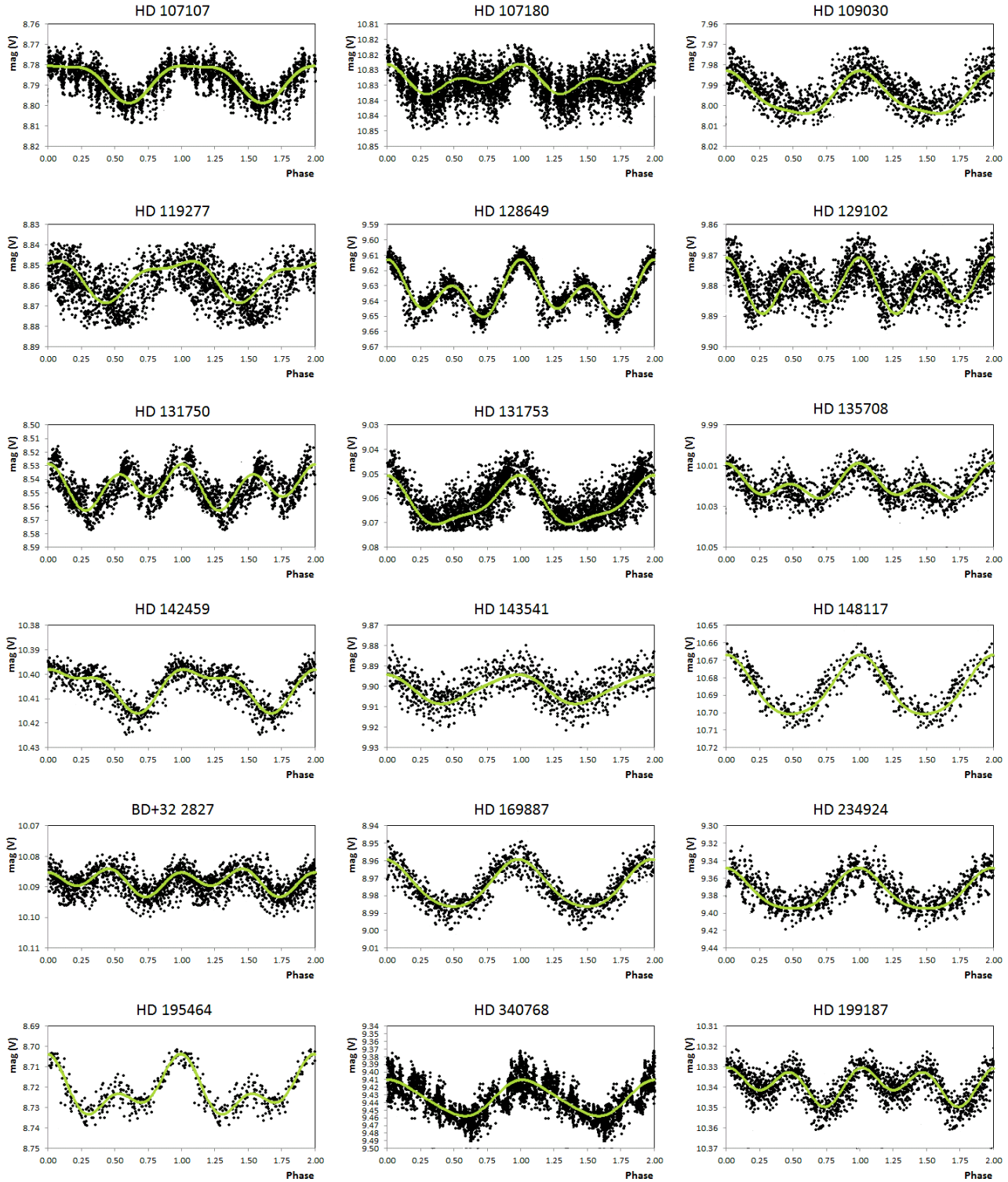


Fig. 1 continued.

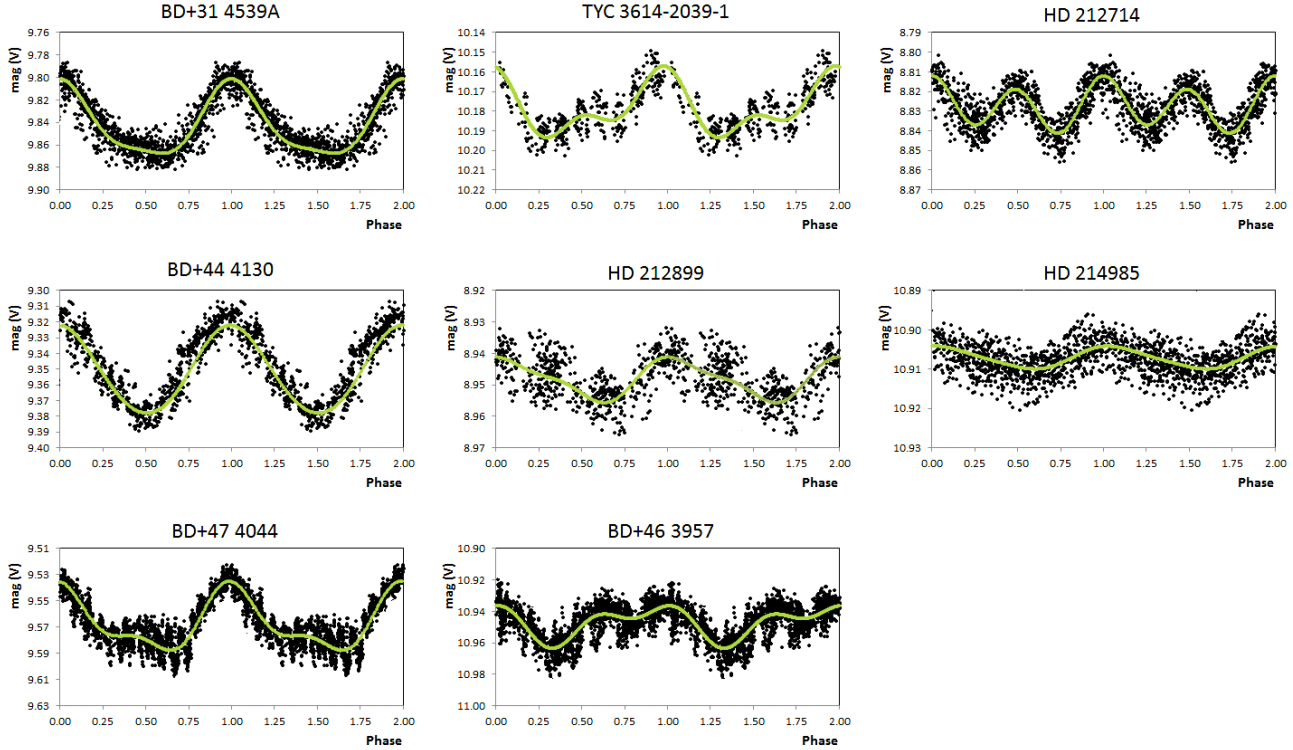


Fig. 1 continued.

of most CP2 stars can be adequately described by a sine wave and its first harmonic (cf. Section 3 and Fig. 1.)

For an astrophysical analysis of a possible correlation of the found rotational periods with age and mass, for example, the location of the individual stars in the Hertzsprung-Russell-diagram (HRD) has to be estimated. For this, the effective temperature (or colour) and luminosity (or absolute magnitude) need to be calibrated. Such calibrations have been especially developed and tested for the different CP subgroups (Maitzen et al. 1980; Netopil et al. 2008) but they all require some additional information such as photometric data in various systems, an estimation of the reddening, and, most important, knowledge of the distance.

For all stars, Johnson BV (Kharchenko 2001) and 2MASS (Skrutskie et al. 2006) colours are available. The errors for $(B - V)$ are between 0.01 and 0.2 mag whereas they are between 0.02 and 0.05 mag for $(J - H)$. For only four stars (HD 30335, HD 109030, HD 1237040, and HIP 109911), the complete Strömgren $uvby\beta$ measurements are available.

With these sparse data, it is not possible to calibrate the reddening of our sample stars. We therefore used the Galactic location of our targets to calculate the maximum reddening using the model by Schlafly & Finkbeiner (2011), who obtained reddening as the difference between the measured and predicted colours of a star as derived from stellar parameters from the Sloan Digital Sky Survey. For our sample, we find a maximum of $E(B - V) = 1.92$ mag, with a mean of 0.43 mag and a median of 0.33 mag, respectively. Bearing in mind that the total absorption $A_V = 3.1E(B - V)$, the

importance of a reasonable determination is obvious. For none of our targets, a parallax measurement with an accuracy better than 20% is available (van Leeuwen 2007). Taking into account the above listed limitations, we are not able to give reliable astrophysical parameters for the investigated objects.

5 Conclusion

We have carried out a search for photometric variability in confirmed or suspected CP2 stars from the Catalogue of Ap, HgMn, and Am stars (RM09) using the publicly available observations from WASP DR1. Around 3 850 000 individual photometric measurements were analysed, which resulted in the discovery of 80 variables, from which 74 are reported here for the first time. Among this number are 23 stars which had been reported as probably constant in the literature before. In agreement with the literature, our light curve analysis confirms that the light curves of most CP2 stars can be adequately described by a sine wave and its first harmonic. Because of the scarcity of suitable photometric data and the lack of parallax measurements with an accuracy better than 20%, we are not able to give reliable astrophysical parameters for the investigated objects.

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